National Program 211 – Water Availability and Watershed Management
Selected Accomplishments for FY 2009

A new remote sensing technique to estimate nutrient uptake by cover crops. Cover crops have been shown to be an effective way to reduce nitrogen losses from agricultural fields, but are difficult to monitor at the watershed/landscape scale. ARS researchers in Beltsville, MD, developed a remote sensing technique to estimate the amount of N sequestered in cover crop biomass on farms enrolled in State cover crop cost share programs. The pilot study was conducted in the Choptank River watershed in MD, part of ARS' watershed research network associated with the Conservation Effects Assessment Project (CEAP). The technique will allow managers to optimize and efficiently monitor this important best management practice at watershed and regional scales with the aid of remote sensing that is non-invasive. (NP 211; Performance Measure 5.2.1)

Developing sensors and procedures for corn N management. A significant proportion of the nitrogen losses from agricultural lands are associated with nitrogen fertilizers added in excess of crop nitrogen requirements. ARS scientists in Lincoln, NE, finalized the development of the Crop Circle active sensor system for N management through a CRADA with Holland Scientific (Lincoln, NE), and developed procedures for its effective use. Sensor readings provided rapid, accurate assessments of plant canopy greenness. Use of this sensor system to guide variable rate N applications has the potential to improve N use efficiency, enhancing both the environmental and economic quality of corn production, while reducing nitrogen losses from agricultural fields that contribute to the eutrophication of aquatic ecosystems. (NP 211; Performance Measure 5.2.1)

A prototype nitrogen management tool for tile drained agriculture. Nitrogen losses from tile-drained agricultural systems in the upper Mississippi River watershed have been identified as a major factor contributing to the annual development of the hypoxic zone in the Gulf of Mexico. ARS researchers at Ames, IA, and Tucson, AZ, collaborated to develop a prototype spreadsheet tool capable of estimating N lost to surface waters from tile-drained agriculture. The tool uses statistical relationships from values measured in field experiments combined with a simulation model, providing a simple way to calculate the expected reduction in N loading from potential management changes. The prototype has the potential to become an operational N management tool for use by farmers, growers, and natural resource managers, that will help maintain the sustainability of US agricultural practices while enhancing the environment. (NP 211; Performance Measure 5.2.1)

Enhanced nitrogen use efficiency in potato production. Better management of nitrogen fertilizer applications provide economic benefits to farmers and improve water quality. ARS scientists at Kimberly, ID, developed an alternative potato production system using 12-foot wide beds with five or seven rows across each bed. This alternate production system increases N use efficiency, increasing gross returns up to $300 per acre over conventional potato production in hilled rows. Western Ag Research, Blackfoot, ID, received a Conservation Innovation Grant in 2007 to demonstrate and evaluate this technology on 10,000 acres in southern ID. (NP 211; Performance Measure 5.2.1)

Development of a river basin scale water quality model. Simulation models are critical to the accurate assessment of water quality concerns and the effects of conservation practices aimed at improving water quality. ARS scientists at the Grassland, Soil and Water Research Laboratory, Temple, TX, have developed a river basin scale model called SWAT (Soil and Water Assessment Tool) that integrates hydrology, soil erosion, plant growth, and nutrient cycling, with off-site processes such as channel erosion/deposition, pond and reservoir processes, groundwater flow, and climate variability. Numerous interfaces have been developed for the model to assist users in obtaining model inputs and interpreting model outputs. The model was calibrated and validated, and uncertainty in its output was analyzed, based on observations from the CEAP Benchmark Watersheds and other watersheds around the world. In general, the model compared well with observed stream flow and sediment and nutrient loads and concentrations. The model is being used across the country by US EPA to assess water quality concerns, and by USDA to assess the environmental impact of conservation programs on water quality and quantity. Scientists around the world are contributing to model development; over 350 scientific papers have been published in the open literature on the development and application of SWAT. (NP 211; Performance Measure 5.2.1)

Data and information from ARS Watersheds are assembled to address National research and conservation needs. Vast quantities of scientific data are collected annually in the US, but the benefits of such data collection activities are not fully realized unless these datasets are stored and maintained for integrative analysis and potential future use. ARS researchers and staff from El Reno, OK, Columbia, MO, Beltsville, MD, Ames, IA, and Fort Collins, CO, developed a web-based data system—Sustaining the Earth's Watersheds, Agricultural Research Data System (STEWARDS)—that organizes and documents soil, water, climate, land-management, and socio-economic data from multiple agricultural watersheds across the US, allowing users to search, download, visualize, and explore data for research and conservation management purposes. STEWARDS is currently being beta-tested by the CEAP research team. When released to the public, STEWARDS will help: 1) researchers obtain ARS' long-term data for hydrological studies; 2) modelers retrieve data for model calibration and validation; and 3) watershed managers and a wide array of partners and stakeholders access long term data to support conservation planning and assessment. (NP 211; Performance Measure 5.2.1)

Assessing effectiveness of conservation practices within the Little River watershed. One of the benefits of long-term data collection relates to the potential for subsequent integrative and comprehensive analyses. ARS scientists have collected stream flow and water quality data on the Little River Experimental Watershed (LREW) in South-Central GA for the past 37 years, and sediment and agrichemical concentrations in stream flow for the past 20 years. The resulting database contains hydrologic and water quality data, combined with terrain, soils, geology, vegetation, and conservation practices, for this watershed. The database was published in six manuscripts and via a public ftp site, and is being used to closely examine long-term water quantity and quality patterns for the watershed. The research illustrates the dramatic importance of riparian buffers within the watershed, which remove sediment and nutrients from upland agricultural sources, preventing them from entering adjacent streams and causing eutrophication. (NP 211; Performance Measure 5.2.1)

A new management practice for reducing nitrate loss in drainage waters. Nitrogen losses from agricultural fields are an important contributor to the eutrophication of Chesapeake Bay. Best management practices aim to reduce N losses, thereby improving water quality. In the Choptank River Special Emphasis Watershed (SEW), MD, excess nutrient transport from agricultural fields is primarily through extensive open drainage ditches, where on average, 6% of the nitrate applied annually may be transported to streams, rivers, and eventually the Chesapeake Bay. One of the best management practices (BMPs) used in these ditches is the installation of water control structures at the drainage outlet to reduce water flow and nutrient loss. Preliminary studies indicate that increasing water table elevation to just below the root zone during the growing season, while lowering it during planting and harvesting operations, can reduce nitrate losses up to 40%. These findings provide quantitative efficiencies for both water and nitrate reductions, and better management strategies for more efficient use of controlled drainage BMPs. (NP 211; Performance Measure 5.2.1)

Water quality modeling for large-scale watersheds. Agricultural pollutants in drainage waters have the potential to degrade the quality of waters used for municipal water supplies. ARS scientists in West Lafayette, IN, successfully calibrated and validated SWAT for modeling stream flow and atrazine concentrations in the Cedar Creek Watershed (CCW). This research is necessary for further use of SWAT as an assessment tool to evaluate the long-term effects of different management practices on chemical transport in large, tile-drained agricultural watersheds in the Midwest. The results are significant in that Cedar Creek is the main tributary to the St. Joseph River, the source of water supply for Ft. Wayne, IN, where concentrations of atrazine and other agricultural pollutants have been a major concern. (NP 211; Performance Measure 5.2.1)

Vegetative buffers help reduce nutrients in soil and groundwater. Vegetative buffers are often used to reduce pollutant exports in waters draining from agricultural fields. Effective vegetative buffers require grass species that can capture nutrients before they run off the surface or leach to groundwater. ARS scientists at Columbia, MO, in collaboration with scientists at the University of Missouri, conducted a field study using five grass treatments (orchardgrass, tall fescue, smooth bromegrass, timothy, and switchgrass) compared to a bare ground control, to evaluate the ability of the grasses to remove nutrients, preventing their transport to shallow groundwater. All grass species except timothy reduced nitrate concentrations in shallow groundwater by ~99% compared to the control; switchgrass also reduced phosphate leaching by 60 to 74%. Grass treatments reduced soil nitrate levels by 41 to 91%. Overall, switchgrass, smooth bromegrass, and tall fescue were the most suitable for use in vegetative buffers because of their superior ability to reduce soil nitrate and nutrient leaching. These findings provide important information to improve the design of vegetative buffers, increasing their effectiveness in nutrient removal. (NP 211; Performance Measure 5.2.1)

Refining constructed wetland technologies for treating agricultural runoff. Degradation of water quality due to agricultural pollution is of global concern. Some treatment strategies use constructed, natural, or restored wetlands as buffers between agricultural fields and nearby water sources. ARS scientists at Oxford, MS, found that the long-term growth patterns of live, caged mussels placed in a constructed wetland were affected by insecticide received in artificial runoff, and documented elevated releases of phosphorus during winter die off when a common wetland plant species was exposed to elevated levels of nitrogen and phosphorus. These findings will help refine technologies that use wetlands to ameliorate agricultural pollution, allowing more informed decisions regarding nutrient and insecticide best management practices. (NP 211; Performance Measure 5.2.1)

Improvements in riparian area modeling for water quality assessment. Accurate modeling of water movement through riparian buffers is critical for watershed-scale water quality assessments. ARS scientists at Beltsville, MD, and Tifton, GA, tested the Riparian Ecosystem Management Model (REMM) using a GA riparian database. The sensitivity of REMM nutrient and sediment output was quantified with respect to changes in key riparian buffer parameters (e.g., vegetation; soil characteristics). Parameters associated with vegetation (e.g., rooting depth; plant height) moderately affected nutrient and sediment yields, but outputs were highly sensitive to changes in physical parameters (e.g., slope; Manning's surface roughness coefficient). Scientists at Beltsville are developing a similar evaluation of REMM for the Choptank SEW. This new model will assist farmers and policy makers in quantifying the effectiveness of specific riparian buffers in reducing pollutant loads to streams and other surface waters. (NP 211; Performance Measure 5.2.1)

Plants for saline water reuse. High salinity levels prohibit the reuse of irrigation drainage waters from agricultural fields in the western US. ARS researchers at Parlier, CA, identified plant species and poplar tree clones adapted to these high salinity waters. As an example, oil plants adapted to high salinity drainage waters can be used for bio-based products that have economic value for the grower (e.g., biofuel and Se-enriched feed products). These findings improve our ability to sustain an agronomic-based system for drainage water reuse and encourage widespread use of degraded water for non-human consumptive uses, reducing competition for high quality water in the western U.S. (NP 211; Performance Measure 5.2.1)

Salt Management Guide helps growers select horticultural crops that thrive in recycled waters. To assist landscape professionals, growers, and home gardeners in managing salinity in recycled irrigation waters, ARS scientists at the US Salinity Laboratory, Riverside, CA, in collaboration with researchers at the University of California Davis, developed a **Salt Management Guide**. The Guide and accompanying CD include an extensive list of plant species suitable for water reuse systems, ranging from relatively non-saline settings to salt-affected problem sites. The product provides: 1) information on public health aspects, and regulations on use, of Title 22 waters, and their suitability for landscape irrigation relative to plants, soil properties, and irrigation application systems; and 2) information to educate the public about safe use of recycled water and its value in helping to address current and future shortfalls in potable waters. (NP 211; Performance Measure 5.2.1)